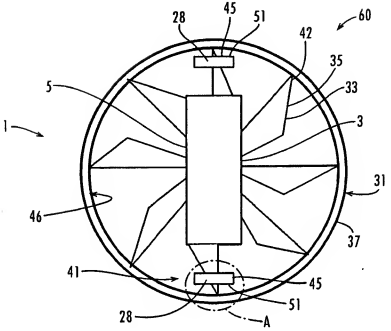


Fig. 1

APPROVED: /JG/

/JG/ 02/12/2009

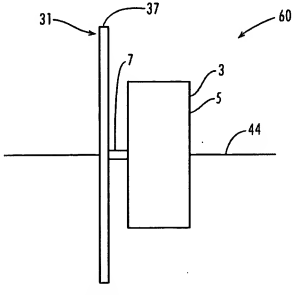


Fig. 2

APPROVED: /JG/

/JG/ 02/12/2009

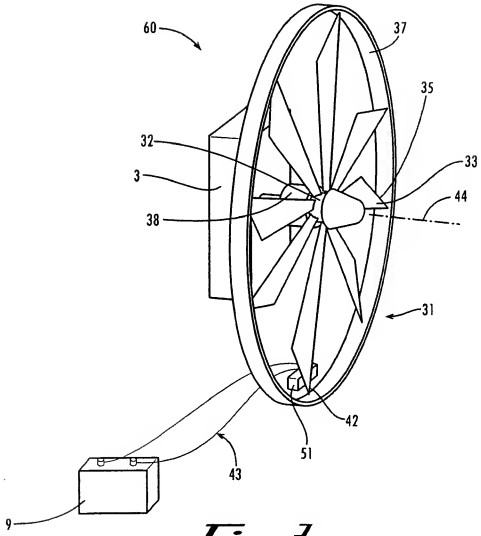


Fig. 3

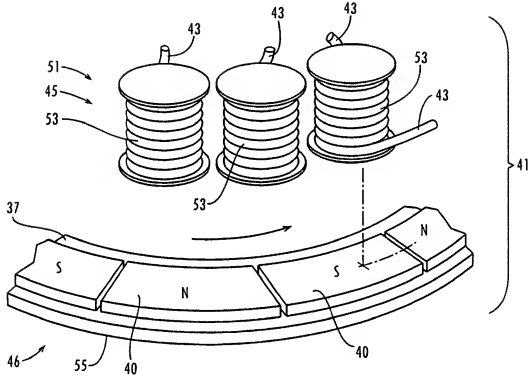


Fig. 4

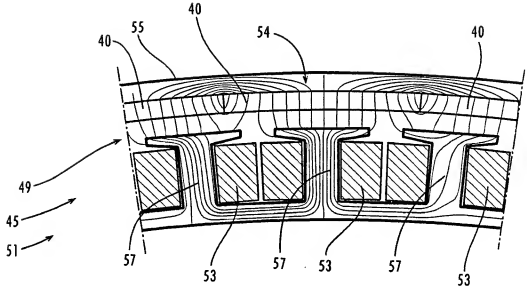
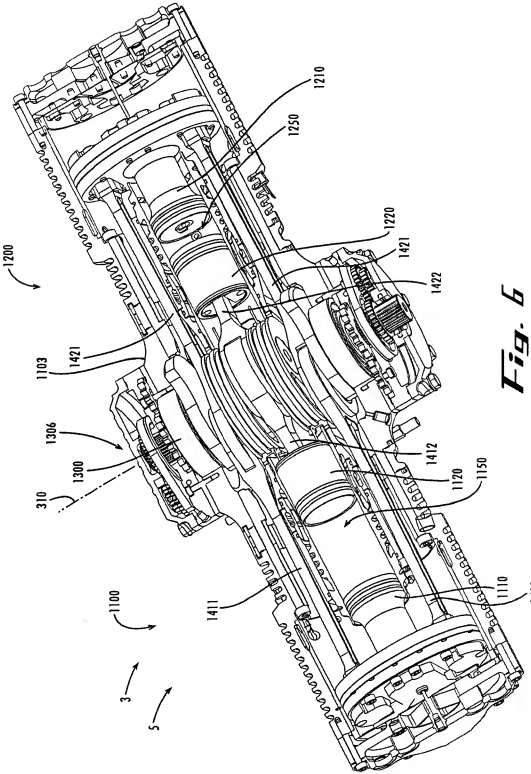


Fig. 5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1411
1100
3
5

Fig. 6

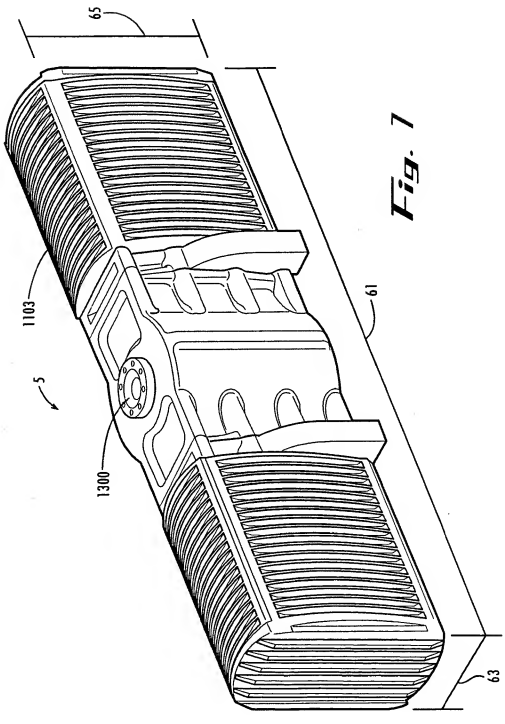


Fig. 7

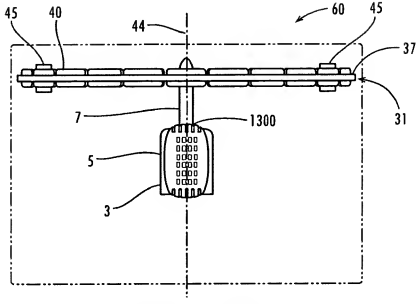


Fig. 8A

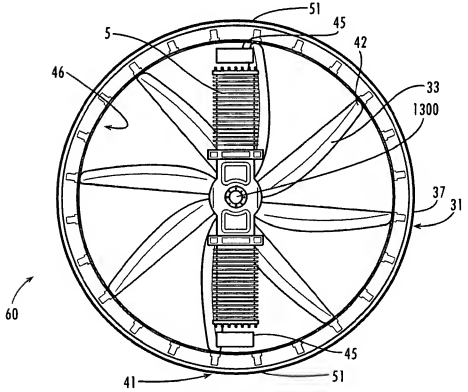


Fig. 8B

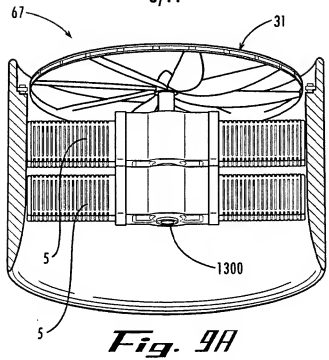


Fig. 9A

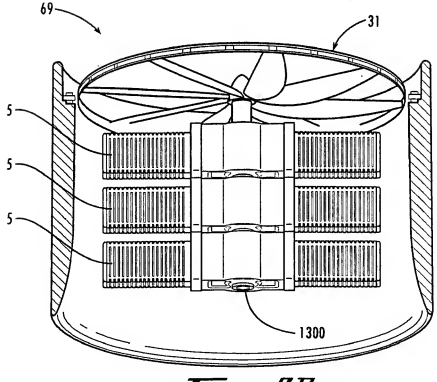


Fig. 9B

Engine Design Input Data

Cylinder Bore	B	32	mm
Engine Stroke	S	60	mm
Conrod Length	L	50	mm
Engine Speed	N	9182	rpm
Compression Ratio	CR	19	
Intake/Boost Pressure (abs)	Pi	0.9	bar
Intake/Boost Temperature	Ti	20	C
Fuel (D for diesel, G gasoline, M methanol)		d	
Stroke (FOUR for 4 stroke, TWO 2 stroke)		two	
Relative Air/Fuel ratio	Lambda	1.5	
Number of Cylinders	n	2	

Estimated Engine Performance Data

Cylinder Peak Pressure	Pmax	66	bar
Peak Pressure Phase (ATDC)	Alpha	5	deg
Break Mean Effective Pressure	BMEP	4.52	bar
Engine Power at the Given Speed	P	9.0	hp
Engine Torque at the Given Speed	T	6.9	Nm

Fig. 10

FAMILY 1a (two cylinder unit = opoc module, two gear-set)

Cyl.	Mach	Speed	MPS	Piston Stroke		Power		opoc Weight		BSFC		Eff	Transmission	
Nr.	Nr.	rpm	n/sec	cm	in	hp	kW	g	lbs	g/kWh	lbs/hp-hr	%	Planetary Transmission	
2	0.85	12500	11.0	2.64	1.04	9	6.7	1825	4.0	500	0.822	17%	Direct drive	
4	0.85	12500	11.0	2.64	1.04	17	12.7	3950	8.7	480	0.789	18%	Gear ratio: 1 =	0.66
6	0.85	12500	11.0	2.64	1.04	42	31.3	7743	17.1	430	0.707	20%	Gear ratio: 1 =	0.39

FAMILY 1b (only one standardized one cylinder unit = opoc module, but three gear-set)

Cyl.	Mach	Speed	MPS	Piston Stroke		Power		opoc Weight		BSFC		Eff	Transmission	
Nr.	Nr.	rpm	n/sec	cm	in	hp	kW	g	lbs	g/kWh	lbs/hp-hr	%		
2	0.68	10000	10.0	3.00	1.18	9	6.7	3150	6.9	450	0.740	19%	Direct drive	1.2
4	0.68	10000	10.0	3.00	1.18	17	12.7	6250	14.0	430	0.707	20%	Gear ratio: 1 =	2.08
6	0.748	11000	11.0	3.00	1.18	42	31.3	9550	21.1	400	0.658	21%	Gear ratio: 1 =	0.45

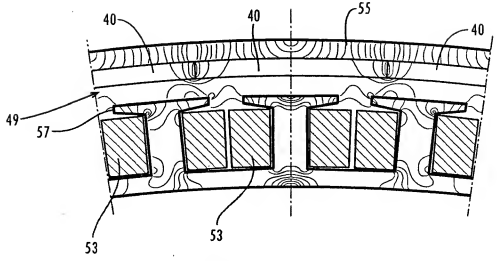
FAMILY 2 (two cylinder units = opoc modules, one gear-set, no 6 cylinder)

Cyl.	Mach	Speed	MPS	Piston Stroke		Power		opoc Weight		BSFC		Eff	Transmission	
Nr.	Nr.	rpm	n/sec	cm	in	hp	kW	g	lbs	g/kWh	lbs/hp-hr	%		
2	0.85	12500	11.0	2.64	1.04	9	6.7	1825	4.0	500	0.822	17%	Direct drive	
2	0.85	8300	11.0	3.98	1.57	17	12.7	5125	11.3	400	0.658	21%	Direct drive	
4	0.85	8300	11.0	3.98	1.57	42	31.3	10600	23.4	380	0.625	23%	Gear ratio: 1 =	0.59

FAMILY 3 (three cylinder units = opoc modules, all direct drive and 2 cylinders)

Cyl.	Mach	Speed	MPS	Piston Stroke		Power		opoc Weight		BSFC		Eff	
Nr.	Nr.	rpm	n/sec	cm	in	hp	kW	g	lbs	g/kWh	lbs/hp-hr	%	
2	0.85	12500	11.0	2.64	1.04	9	6.7	1825	4.0	500	0.822	17%	Direct drive
2	0.85	8300	11.0	3.98	1.57	17	12.7	5125	11.3	400	0.658	21%	Direct drive
2	0.85	4900	11.0	6.73	2.65	42	31.3	24950	55.0	340	0.559	25%	Direct drive

Fig. 11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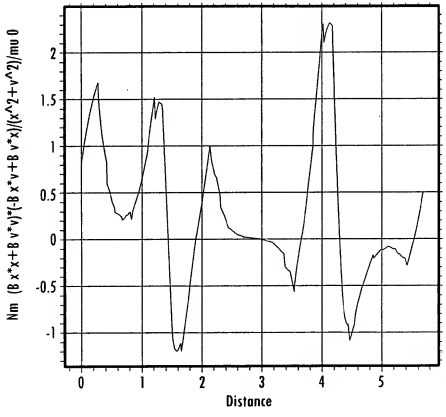
49
57
53
53

Fig. 12


Nm (B x*x+B v*v)*(-B x*v+B v*x)/(x^2+v^2))/mu 0
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1.5
1
0.5
0
-0.5
-1
0
1
2
3
4
5
Distance

Fig. 13